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Sainfoin for western Canada

Canada

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Recommendations for pesticide use in this publication are intended as guidelines only. Any application of a pesticide must be in accordance with directions printed on the product label of that pesticide as prescribed under the Pest Control Products Act. **Always read the label.** A pesticide should also be recommended by provincial authorities. Because recommendations for use may vary from province to province, consult your provincial agricultural representative for specific advice.

Cover illustration
Sainfoin plant

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Contents

Acknowledgments 5

Tips for growing sainfoin 6

Introduction 7

Characteristics 8

Adaptation 9

Cultivars 9
Melrose 9
Nova 11

Inoculation and fertilizer requirements 11

Seeding 13

Weed control 14

Usage and management 15

Seed production 18

Diseases and insects 20

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Tips for growing sainfoin

- Use the Canadian-bred cultivars Melrose or Nova.
- Always treat seed with sainfoin inoculum before seeding.
- For dryland pasture, seed sainfoin alone or in a mixture with Russian wildrye or crested wheatgrass.
- For hay or pasture on irrigated land, seed sainfoin alone.
- Seed "in the pod" at 25–35 seeds per metre of row; this rate is equivalent to about 7–40 kg/ha, depending on how far apart the rows are spaced; reduce the seeding rate by one-third in mixtures with grasses.
- Seed no deeper than 2 cm into a firm, weed-free seedbed.
- Do not use a companion crop.
- For hay, cut sainfoin at the 75–100% bloom stage.
- For pasture, graze in the bud or early bloom stage to encourage regrowth.
- Grow sainfoin for seed on dry or irrigated land; space rows 60–90 cm apart.
- Provide honey bees or alfalfa leafcutting bees for pollination.
- Swath seed crops when the lower pods have turned brown, but before they can shatter.
- Combine as soon as the seed is dry, usually 7–10 days after swathing.

Introduction

Sainfoin is a perennial forage legume that has been grown in parts of Europe and Asia for hundreds of years. Various strains and accessions have been introduced to North America since about 1900. Most of the early introductions originated in western Europe and were low yielding and poorly adapted to North American conditions. Recent introductions from the USSR and Turkey have shown greater promise, and more farmers have been growing the crop since the release of improved cultivars in Canada and the United States.

Most cultivated sainfoins (Fig. 1) are identified as *Onobrychis viciifolia* Scop. At least two other species are grown in the USSR and China, but they are not readily distinguishable from *O. viciifolia*.

Fig.1 ***Left*****, sainfoin heads in flower;** ***right*****, fully ripened seed.**

Characteristics

No cultivated sainfoin is known to cause bloat in livestock. Sainfoin may grow to a height of 1 m or more and is usually somewhat taller than alfalfa. The stems are hollow. The leaves are divided, like those of vetch, into a large number of leaflets. Sainfoin develops a deep, branched taproot. The attractive, rosy-pink flowers, borne on spike-like heads, are particularly characteristic of the crop (Fig. 1).

The large, brown, single-seeded pods (Fig. 2) are distinctive, because of a raised network of veins. They often have short spines along one edge. When mature, they shatter from the plant with their seeds still tightly enclosed. The seeds (Fig. 2) are smooth, kidney-shaped, olive brown to dark brown, and average about 3 mm in length. They are held within the tough, fibrous pods during harvesting, threshing, and subsequent seeding.

The crop is easy to establish. The seeds, which are seeded "in the pod," germinate readily and produce vigorous seedlings that grow rapidly.

Sainfoin begins to grow in the spring before other perennial legumes and starts blooming as much as 2 weeks before alfalfa. Winter-hardy strains give hay and pasture yields within 80–90% of those of alfalfa except under very dry conditions. Its blooming and ripening period is also shorter than that of alfalfa. Sainfoin matures early and gives particularly good forage yields under a one-cut system. At Lethbridge, Alberta, sainfoin is ready to harvest for seed in late July or early August, whereas alfalfa is

Fig. 2 ***Upper left*****, sainfoin pods;** ***centre*****, true seeds;** ***upper right*****, alfalfa seeds for size comparison.**

rarely ready before mid September. On the other hand, most sainfoin cultivars recover more slowly after cutting or grazing than alfalfa and do not produce as much regrowth. It usually yields less when grazed or cut twice or more in a season. During the autumn, the plants develop a low, rosette growth that may remain green under snow cover for most of the winter. Seedlings and mature plants are highly tolerant of spring and fall frosts.

Sainfoin is immune to attack by the alfalfa weevil, one of the most serious insect pests of alfalfa.

Adaptation

The Canadian cultivars of sainfoin appear to be adapted to most of those areas in western Canada where alfalfa can be grown. However, even these sainfoins have been winter-killed in tests at some locations and must be considered somewhat less hardy than the recommended alfalfa cultivars.

Sainfoin grows best on Brown, Dark Brown, and Black soils unless moisture is severely limiting; it generally yields less on Gray Luvisol (Gray Wooded) and Light Brown soils. Sainfoin has the reputation of being drought-resistant. It has persisted under very dry conditions in some Canadian tests, but forage yields have been low. In Montana, the crop is not recommended for dryland production in areas where the annual precipitation is less than 300 mm. In western Canada, follow a similar guideline.

Sainfoin yields best on deep, well-drained soils that have good moisture-holding capacity and are high in lime and near neutral. Unlike other legumes, it also does well on thin, gravelly soils. Sainfoin does not tolerate either saline or wet soils, or high water tables. It responds to irrigation but does not need irrigating as frequently as alfalfa.

Cultivars

Melrose

This cultivar was the first registered (licensed) in Canada. It was selected at Saskatoon in 1963 from among a group of 27 sainfoin introductions received from Leningrad, USSR. The most promising accession was chosen and, with further selection and cooperative research among the research stations at Melfort, Lethbridge, and Saskatoon, a productive and winter-hardy Canadian sainfoin cultivar was released in 1969. In tests at 11 locations across western Canada during 1967–1976, Melrose produced an average of 11% more forage and 27% more seed than the cultivar Eski from Montana (Tables 1 and 2).

Table 1 Forage yield of sainfoin and alfalfa cultivars at 10 dryland and 4 irrigated locations in western Canada, 1967–1976

Location	Number of station-years	Sainfoin (kg/ha)		Alfalfa* (kg/ha)	Yield of Melrose as % of alfalfa
		Melrose	Eski		
Dryland tests					
Winnipeg, Man.	2	11 220	10 420	10 730	105
Melfort, Sask.	10	4 300	3 360	4 880	88
Saskatoon, Sask.	11	5 200	5 010	6 520	80
Swift Current, Sask.	5	1 940	1 850	2 380	81
Indian Head, Sask.	10	3 220	2 690	3 500	92
Beaverlodge, Alta.	4	1 720	1 310	2 220	77
Lacombe, Alta.	2	4 690	3 750	4 320	109
Lethbridge, Alta.	14	7 590	7 050	8 900	85
Vanderhoof, B.C.	2	1 690	1 100	7 290	23
Williams Lake, B.C.	1	750	720	2 310	33
Irrigated tests					
Saskatoon, Sask.	1	1 280	960	4 460	29
Swift Current, Sask.	3	6 930	6 150	9 040	77
Lethbridge, Alta.	5	7 600	7 250	7 530	101
Kamloops, B.C.	2	5 640	4 930	6 530	86
Average (72 station-years)		5 040	4 520	5 970	84

* Beaver or Ladak, depending on location and year.

Table 2 Seed yield of Melrose and Eski sainfoin at six dryland locations in western Canada, 1967–1976

Location	Number of station-years	Seed yield (kg/ha)	
		Melrose	Eski
Melfort, Sask.	7	830	520
Saskatoon, Sask.	7	1080	1040
Indian Head, Sask.	2	200	160
Beaverlodge, Alta.	2	310	170
Lacombe, Alta.	1	1230	1000
Lethbridge, Alta.	6	950	680
Average (25 station-years)		850	670

Nova

Nova, the second cultivar developed in Canada, was released by the Lethbridge Research Station in 1980. This cultivar traces to an importation of seed originating from the Kazakhstan region of the USSR. Nova is similar in type to Melrose and Eski. Like Melrose, Nova flowers sparsely in the year of seeding. In spring vigor, Nova is slightly better than Melrose and much better than the Montana cultivars Eski and Remont; it is taller than all other cultivars (Table 3). Nova is somewhat more winter hardy than Melrose. Following the severe winter of 1978–1979 at Lethbridge, Nova suffered a 7% loss of stand compared with 22% for Melrose and more than 90% for Eski and Remont. Forage data over 20 station-years at nine locations in western Canada showed Nova to yield 7% more forage than Melrose (Table 4). Nova and Melrose are similar in seed yield and much higher than the Montana cultivars Eski and Remont (Table 5).

Table 3 Spring vigor, height at time of cutting, and regrowth after cutting of sainfoin cultivars at various locations in western Canada

Character	Number of station-years	Sainfoin			
		Nova	Melrose	Eski	Remont
Spring vigor[1]	11	2.5	2.9	4.0	4.2
Height (cm)	5	96	91	87	91
Regrowth[2]	6	2.9	3.1	3.4	1.3

[1] On a scale of 1-9, 1 = best.
[2] On a scale of 1-5, 1 = best.

Inoculation and fertilizer requirements

Inoculation is recommended, and sainfoin requires a specific strain of inoculant distinct from that required for alfalfa or any other legume. Inoculum for sainfoin can be obtained from most farm supply outlets and seed companies.

Responses to inoculation have not been consistent. Forage yields were compared in plots established with inoculated and uninoculated seed in 1968 at Lethbridge; yields from the inoculated plots were about 33% higher in 1969 and 28% higher in 1970. In some other tests and field plantings, plants developed signs of nitrogen deficiency even though the seed had been inoculated. This deficiency suggests that the nitrogen-fixing bacteria applied were ineffective or short-lived. Occasionally, symptoms of nitrogen deficiency develop in sainfoin plants early in the growing season and later disappear.

Table 4 Forage yields of sainfoin cultivars in nine trials at seven locations on dryland, 1975–1979

Location and year of seeding	Harvest year	No. of cuttings	Forage yield (dry matter, kg/ha)			
			Nova	Melrose	Eski	Remont
Lethbridge						
1974	1975	3	8 694	9 409	8 591	11 312
	1976	3	10 770	10 497	10 147	11 463
	1977	3	9 956	9 797	8 839	11 177
	1978	2	6 356	6 733	6 775	6 555
1976	1976	1	3 667	2 743	2 450	2 337
	1977	3	14 643	13 589	13 517	13 546
	1978	2	8 683	7 883	7 576	7 757
Saskatoon						
1976	1977	1	4 122	4 034	3 760	2 909
	1978	1	3 019	2 978	2 137	1 500
	1979	1	3 292	3 057	1 238	585
1977	1978	1	3 398	3 658	3 360	3 136
	1979	1	5 809	5 798	5 133	4 764
Indian Head						
1977	1978	1	6 539	6 823	6 791	5 292
	1979	2	6 515	6 247	5 844	5 887
Melfort						
1976	1976	1	2 055	1 676	1 502	2 164
	1977	2	4 669	4 021	3 608	2 925
	1978	1	3 754	1 914	1 669	1 228
Beaverlodge						
1976	1977	2	7 932	7 625	6 581	6 551
Lacombe						
1976	1977	2	9 228	8 397	7 705	5 296
Kamloops						
1979	1979	2	8 066	6 322	5 865	6 667
Average (20 station-years)			6 558	6 160	5 654	5 652
as % of Melrose			107	100	92	92

Nitrogen fertilizer may have to be applied to sainfoin on nitrogen-deficient soils until improved strains of the bacteria have been selected and included in the commercial inoculants.

The few trials that have been conducted with fertilizers indicate that added phosphorus increases neither forage nor seed yield.

Table 5 Seed yields of sainfoin cultivars in four trials at four locations, 1977–1979

Location and year of seeding	Harvest year	Seed yield (kg/ha)			
		Nova	Melrose	Eski	Remont
Lethbridge*					
1976	1977	1044	1049	954	405
	1978	1413	1350	1174	482
	1979	695	387	555	205
Saskatoon					
1976	1977	869	757	706	351
	1978	399	450	375	177
	1979	597	813	640	461
Saskatoon					
1977	1978	328	331	175	143
	1979	454	342	239	418
Beaverlodge					
1976	1977	1019	1157	811	357
Average (9 station-years)		758	737	625	333
% of Melrose		103	100	85	45

* Irrigated test.

Seeding

Sainfoin is usually seeded in the pod, and therefore further references in this publication to seeds are to the pods with true seeds still enclosed.

For pure stands, seed at about 25–35 seeds per metre of row, whether the crop is for hay, pasture, or seed. Recommended row spacings and seeding rates are given in Table 6.

Table 6 Row spacings and seeding rates for sainfoin grown for various purposes

Purpose of crop	Row spacing (cm)	Seeding rate (kg/ha)
Irrigated hay	15–18	34–40
Dryland hay or pasture	30–45	13–20
Irrigated or dryland seed production	60–90	7–10

If a sainfoin–grass mixture is to be seeded for hay or pasture, reduce the seeding rate of each species to about two-thirds of that recommended for pure stands. To improve your chances of obtaining a good stand:

- prepare a firm seedbed; some form of packing is usually needed, except on heavy soils subject to crusting and compaction
- seed at the recommended rate
- seed without a companion crop; sainfoin seedings are vigorous but do not compete well with other plants at early stages of growth
- seed in early spring; fall seedings have been successful at Lethbridge, but the later the crop is seeded the lower the yield of forage or seed will be in the year after seeding
- seed shallow, 1–2 cm; despite its large seed size, sainfoin does not emerge well from deep plantings.

Sainfoin can be seeded with almost any type of seed drill. It is an advantage to use a seeder with some means of depth control. To check the seeding rate, run the drill over a canvas or some hard surface and then count the number of seeds dropped over a measured length of row.

Weed control

Sainfoin should be established with minimal competition from weeds or a companion crop. The effect of weeds in the seedling stand on sainfoin yield, in the year following establishment, can be related to the amount of weed growth. Light weed infestations have little effect, whereas weed infestations with dry matter production similar to that produced by a companion crop reduce sainfoin yield by up to 30% in the year after establishment. Normally, sainfoin recovers from competition from weeds or a companion crop in the 2nd year after establishment.

In sainfoin established without severe competition from weeds or a companion crop, vigorous sainfoin growth in the year following establishment usually prevents serious infestations of annual and winter annual weeds. In a vigorous sainfoin stand, weed yields are usually less than 5% of the total dry matter yield in the year after establishment. However, weeds may contribute more than 20% of the total dry matter yield, especially in sainfoin that was established in competition with weeds or a companion crop. The most abundant weeds the year after establishment are either winter annuals such as flixweed, stinkweed, and shepherd's-purse, or early germinating weeds such as kochia. Sainfoin established with or without competition from weeds usually competes successfully not only with annual broadleaf weeds and grasses in the 1st year after establishment, but also with winter annuals in the 2nd year after establishment. The main weeds in older established stands are perennial weeds such as dandelion, quack grass, sow-thistle, and Canada thistle. These perennial weeds generally infest sainfoin more than alfalfa stands.

Few herbicide treatments are registered for use on seedling or established sainfoin. Therefore, choose carefully fields for seeding sainfoin

that are not heavily infested with weeds, especially perennial weeds. Sainfoin may be mowed in the seedling year to reduce competition from annual weeds without injuring the crop. Cultivation is effective for controlling weeds in spaced-row plantings for seed production. Treflan may be applied prior to seeding sainfoin for forage or seed production to reduce competition from wild buckwheat, barnyard grass, chickweed, green foxtail, lamb's-quarters, wild oats, and redroot pigweed.

No herbicides are registered for weed control in established sainfoin for forage production. If sainfoin is intended for seed production, then the following additional herbicides may be applied in the seeding year:

- Basagran for control of mustards, smartweeds, and corn spurry
- Mataven for control of wild oats
- Hoe-Grass 284 for control of barnyard grass, green foxtail, and wild oats
- Poast for control of barnyard grass, volunteer cereals, green foxtail, and wild oats, and for suppression of quack grass.

In established sainfoin for seed production, Poast may be used to control annual grasses and to suppress quack grass. These herbicides are only registered for use in western Canada except for Mataven, which also may be used in eastern Canada. Hoe-Grass use is restricted to the three Prairie Provinces and to the Peace River area of British Columbia.

Usage and management

Interest in sainfoin has centred on its potential for pasture because it does not cause bloat (Fig. 3). It has withstood close grazing or cutting in dryland tests for as long as 5 years, but there are indications that the crop may be shorter lived than alfalfa, particularly when it is irrigated. As a hay crop, sainfoin can be grown on dry and irrigated land.

Sainfoin for pasture can be seeded alone or in mixtures with grasses. The highest yields have been obtained from sainfoin grown alone. On dryland at Lethbridge, it has done well combined with bunchgrasses such as Russian wildrye and crested wheatgrass but has yielded poorly in mixtures with aggressive, rhizomatous species such as smooth bromegrass and pubescent (intermediate) wheatgrass. From 1967 to 1971 in a test of dryland mixtures at Lethbridge, sainfoin contributed 61% of the total dry-matter yield when grown in combination with Russian wildrye and 48% with crested wheatgrass. However, it contributed only 19% of the total yield in combination with pubescent wheatgrass (Table 7).

Unlike grasses, avoid mowing sainfoin pastures after grazing during the growing season because mowing delays recovery growth; mature plants retain good palatability. We recommend pasture rotation, with the animals grazing four or more separate fields in sequence.

Grown as irrigated hay, most sainfoin–grass mixtures have yielded less than sainfoin alone. In general, yields of the better cultivars of sainfoin on both dryland and irrigated hay and pasture locations have been within 80–90% of those of alfalfa (Table 1).

Fig. 3 Sheep grazing 3-year-old stand of sainfoin and crested wheatgrass.

Table 7 Forage yields of sainfoin, alfalfa, and mixtures with three grasses on dry land at Lethbridge, 1967–1971

Species of mixture	Dry matter	
	5-year average (kg/ha)	Average % legume
Sainfoin alone	6310	100
Alfalfa alone	7110	100
Sainfoin and Russian wildrye	5780	61
Alfalfa and Russian wildrye	6380	58
Sainfoin and crested wheatgrass	5210	48
Alfalfa and crested wheatgrass	6900	66
Sainfoin and pubescent wheatgrass	4840	19
Alfalfa and pubescent wheatgrass	6670	39

Exceptionally good forage yields have been obtained from sainfoin in the year of seeding. In six tests in which 1st-year harvests were taken in 1969 and 1970, Melrose yielded dry matter at an average of 3.6 t/ha compared with 2.9 t/ha for alfalfa. Nova has even higher forage yields during its seedling year than Melrose.

Established plants grow rapidly early in the season and appear to make good use of available moisture during that time. Thus, sainfoin does well and may outyield alfalfa as a hay crop in areas where only one cutting is made. First-cut yields from sainfoin grown under irrigation also may be greater than those from alfalfa. However, because sainfoin is slow to recover after cutting, alfalfa usually produces higher annual yields if second or third cuttings are taken. Regrowth is better when sainfoin is cut or grazed in the bud or early-bloom stages than when it is cut at a more mature stage. However, total seasonal yields of sainfoin are highest when the first crop is cut late (Table 8).

Sainfoin retains its leaves longer than alfalfa and can be harvested at a more advanced stage of maturity without appreciable loss of quality. Cut sainfoin for hay between the 75 and 100% bloom stages for best tonnage and highest yield of nutrients.

Although sainfoin stems appear to be coarse, they remain succulent well into maturity and are more digestible than alfalfa stems. The crop is palatable to all classes of livestock either as hay or as pasture. Sainfoin is similar to alfalfa in feed value and digestibility, but it is usually somewhat lower in protein content at comparable stages of maturity.

In a grazing test with sheep on a subirrigated site at Lethbridge, sainfoin yielded as much as alfalfa over a 5-year period and was more palatable and just as persistent. In 2 of the 5 years, the sheep consumed significantly more sainfoin than alfalfa.

Sainfoin also has performed well in irrigated pastures at Lethbridge. In one grazing trial yearling Hereford steers made 34% greater daily weight gains on sainfoin than on orchardgrass. Weight of beef produced per hectare was about the same because sainfoin supported fewer animals per hectare than orchardgrass, partly as a result of higher waste on sainfoin

Table 8 The effect of stage of growth at time of first cutting on forage yield of irrigated sainfoin at Lethbridge, 1969

Stage of growth at first cut*	Yield of dry matter (kg/ha)			
	Cut 1	Cut 2	Cut 3	Total
Early bud	3210	2620	2040	7 870
Mid-bud	4890	2130	1820	8 830
15% bloom	6260	1730	1390	9 370
75% bloom	8920	2330	1230	12 490

* Second and third cuts taken at 20% bloom.

from trampling and fouling. However, sainfoin had two advantages: it required no nitrogen fertilization, and the steers on it reached heavier weights by fall.

In a feeding trial carried out in Nevada on beef cattle, animal production was found to be similar for alfalfa and sainfoin. Animal gains, intake, and feed efficiency did not differ significantly, although alfalfa was higher in crude fiber and ash and lower in the readily digested nitrogen-free extract. The coarse and stemmy sainfoin hay was equal to alfalfa for grazing cattle in digestibility, intake, and rates of gain.

In a study to compare growth and quality parameters of sainfoin and alfalfa in Bozeman, Montana, alfalfa was consistently higher in crude protein, ash, calcium, and crude fiber but was lower in phosphorous, total digestible nutrients, and nitrogen-free extract. This finding indicates higher energy levels in the sainfoin but lower protein content.

The optimum harvest time for alfalfa is 10% bloom to obtain the greatest protein and energy yields. For sainfoin, harvest should be delayed until 100% bloom is achieved to obtain maximum protein and energy yields. When cut at these stages, alfalfa provides higher protein intake but lower energy levels than sainfoin.

Seed production

Sainfoin can be grown for seed on dryland, but yields are usually higher under irrigation. Spaced rows are preferred to solid stands because they make weed control by cultivation easier (Fig. 4). Row spacings of 30–90 cm have been used successfully, but spacing is governed largely by the tillage equipment available.

The rose-colored flowers occur on terminal, erect, close racemes at the top of the plant (Fig. 1). About 50 flowers per raceme (range 5–120) open from the base of the raceme upwards. A period of 2–3 weeks elapses between the opening of the first flower and the withering of the terminal flowers. The flowering period begins in early to mid June and lasts about 60 days. Sainfoin must be cross-pollinated by bees for optimum seed yield. The flowers secrete nectar excessively and are highly attractive to pollinating insects. At best, only 55% of the flowers that are pollinated produce seed, which is probably because of the genetic and physiological limitations of the plant.

Honey bees and alfalfa leafcutting bees are effective and efficient pollinators. Provide two to three colonies of honey bees per hectare, so that each flower is visited five to six times during peak bloom. Alternatively, provide 20 000 alfalfa leafcutting bees per hectare. The quantity and quality of leafcutting bees produced on sainfoin is similar to production on seed alfalfa. Under good growing conditions, each hectare should yield at least 500–900 kg of cleaned seed; yields of more than 1100 kg/ha have been obtained with the cultivars Melrose and Nova.

Some foreign sainfoin cultivars will produce a seed crop in the seeding year if they are planted early enough. However, Melrose, Nova, and Eski

Fig. 4 Sainfoin in rows spaced 60 cm apart for seed production. Weeds have been controlled by cultivation.

usually do not produce sufficient seed in the 1st year to be worth harvesting. For maximum yields in subsequent years, harvest the seed from the first growth.

In determining when to harvest the seed crop, remember that pods ripen progressively from the base of each flower spike toward the top; the basal pods shatter from the plants before the upper pods are ripe. Therefore, it is advisable to swath the crop after the basal pods have turned brown but before many pods have shattered. Within 7–10 days, most of the immature seed at the upper end of each head will have ripened sufficiently in the swath to allow the crop to be picked up (Fig. 5). Direct combining has been tried successfully by a few seed producers, but it creates a risk of large losses from shattering.

Correct combine settings for sainfoin vary with the make of the machine. Use a slow cylinder speed and wide concave clearance of 0.5–1.5 cm. Ripened pods thresh readily from the stems, so make adjustments so that no broken or shelled seed appears in the hopper. Because of the size and unique shape of the sainfoin pods, they can be separated easily from most weeds.

Fig. 5 Picking up the swathed seed crop.

Unless the combine is equipped with a chopper, remove heavy crops of stems (straw) from seed fields after combining because such residue may smother subsequent regrowth of sainfoin.

Diseases and insects

Reports from countries where sainfoin is widely used suggest that the crop is relatively free from serious disease and insect problems. However, diseases and insects could become important in North America as the area of sainfoin expands.

Root- and crown-rotting diseases have caused concern in Montana and are blamed for the reduced life of many sainfoin stands on both dry and irrigated land. So far, these diseases are not problems in Canada. Winter crown rot is believed to have caused stand losses in test plots during one winter at Lacombe, Alta. Sainfoin is not affected by bacterial wilt and has some tolerance for the alfalfa stem nematode.

The sainfoin seed chalcid, a potentially serious pest, was found infesting up to 20% of the seed produced at Lethbridge, Alta. The female chalcid lays eggs in developing sainfoin pods and the larvae feed on the seed, usually destroying it completely. The larvae remain in the pod and

overwinter in this stage, either in harvested seed pods or in pods lying in the field. Adult chalcids emerge at least 3 weeks before flowering begins, thus providing time to implement chemical control measures. Chemical control of chalcids prior to flowering reduces the potential for harming pollinators with pesticides. Larvae in infested pods subjected to cold treatment (–40°C for 5 days) immediately after harvest were killed but seed germination was not hindered by the cold treatment. Cultural control methods, such as irrigation and cultivation, may be useful measures for destroying infested seed that has shattered in the field.

Although a severe infestation of a seed bruchid peculiar to sainfoin was found years ago in one site in British Columbia where seed had been grown for many years, the insect has not become a serious pest. The presence of this insect, which can seriously damage seed crops, has also been recorded in Alberta, Saskatchewan, and Montana in low numbers. Isolated reports have been made of damage to sainfoin by other insects such as Sitona weevils, blister beetles, and larvae of the spiny elm or mourningcloak butterfly; none of this damage has been at economic levels.

Sainfoin is immune to the alfalfa weevil (Fig. 6), which indicates that the crop could be a useful alternative to alfalfa in areas where this weevil is a problem.

Fig. 6 *Left*, sainfoin is immune to attack by the alfalfa weevil; *right*, upper leaves of alfalfa show damage from feeding by weevil larvae.

CONVERSION FACTORS

Multiply an imperial number by the conversion factor given to get its metric equivalent.

Divide a metric number by the conversion factor given to get its equivalent in imperial units.

Imperial units	Approximate conversion factor	Metric units	
Length			
inch	25	millimetre	(mm)
foot	30	centimetre	(cm)
yard	0.9	metre	(m)
mile	1.6	kilometre	(km)
Area			
square inch	6.5	square centimetre	(cm^2)
square foot	0.09	square metre	(m^2)
square yard	0.836	square metre	(m^2)
square mile	259	hectare	(ha)
acre	0.40	hectare	(ha)
Volume			
cubic inch	16	cubic centimetre	(cm^3, mL, cc)
cubic foot	28	cubic decimetre	(dm^3)
cubic yard	0.8	cubic metre	(m^3)
fluid ounce	28	millilitre	(mL)
pint	0.57	litre	(L)
quart	1.1	litre	(L)
gallon (Imp.)	4.5	litre	(L)
gallon (U.S.)	3.8	litre	(L)
Weight			
ounce	28	gram	(g)
pound	0.45	kilogram	(kg)
short ton (2000 lb)	0.9	tonne	(t)
Pressure			
pounds per square inch	6.9	kilopascal	(kPa)
Power			
horsepower	746	watt	(W)
	0.75	kilowatt	(kW)
Speed			
foot per second	0.30	metres per second	(m/s)
miles per hour	1.6	kilometres per hour	(km/h)
Agriculture			
gallons per acre	11.23	litres per hectare	(L/ha)
quarts per acre	2.8	litres per hectare	(L/ha)
pints per acre	1.4	litres per hectare	(L/ha)
fluid ounces per acre	70	millilitres per hectare	(mL/ha)
tons per acre	2.24	tonnes per hectare	(t/ha)
pounds per acre	1.12	kilograms per hectare	(kg/ha)
ounces per acre	70	grams per hectare	(g/ha)
plants per acre	2.47	plants per hectare	
Temperature			
degrees Fahrenheit	(°F – 32) x 0.56 = °C or °F = 1.8 (°C) + 32	degrees Celsius	(°C)

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